

1 Claims

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3 1. Wave power apparatus comprising:

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5 a plurality of buoyant elongate body
6 members, at least one adjacent pair of body
7 members being interconnected by a linkage unit
8 to form an articulated chain, each body member
9 of said pair being connected to the respective
10 linkage unit by linkage means permitting
11 relative rotation of the body members; and

12

13 power extraction means adapted to resist
14 and extract power from the relative rotation,
15 the power extraction means being located
16 substantially within each linkage unit.

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18 2. Apparatus as claimed in claim 1, wherein the body
19 members are arranged consecutively in an articulated
20 apparatus, each adjacent pair of body members being
21 interconnected by a linkage unit to form an
22 articulated chain.

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24 3. Apparatus as claimed in claim 1 or 2, wherein the
25 or each linkage unit has a longitudinal length
26 substantially shorter than the body members.

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28 4. Apparatus as claimed in any preceding claim, in
29 which the body members substantially comprise hollow
30 members devoid of active components.

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1 5. Apparatus as claimed in any preceding claim,
2 wherein each body member has one or more end caps
3 with corresponding linkage means to marry with the
4 linkage means of the linkage unit.

5
6 6. Apparatus as claimed in any preceding claim,
7 wherein the linkage unit is arranged to permit
8 relative rotation between the linkage unit and a
9 first body member about a first axis of rotation at
10 a first end of the linkage unit, and to permit
11 relative rotation between the linkage unit and a
12 second body member about a second axis of rotation
13 at a second end of the linkage unit.

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15 7. Apparatus as claimed in any preceding claim,
16 wherein the power extraction means includes a
17 hydraulic ram assembly.

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19 8. Apparatus as claimed in claim 7, wherein the
20 hydraulic ram assembly comprises a plurality of
21 rams.

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23 9. Apparatus as claimed in claim 7 or 8, wherein the
24 power extraction means includes a hydraulic ram
25 assembly for each axis of rotation.

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27 10. Apparatus as claimed in claim 9, wherein the
28 power extraction means includes two hydraulic ram
29 assemblies acting about each axis of rotation.

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1 11. Apparatus as claimed in claim 5, wherein the end
2 caps have a number of cavities to receive respective
3 ends of the power extraction means.
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5 12. Apparatus as claimed in any preceding claim,
6 wherein the power extraction means has at least one
7 seal to prevent ingress of water into the linkage
8 unit and/or body members.
9

10 13. Apparatus as claimed in any preceding claim,
11 wherein the linkage unit includes one or more power
12 generation or storage means connected to one or more
13 of the power extraction means.
14

15 14. Apparatus as claimed in claim 13, wherein the
16 linkage unit includes a first power generation means
17 connected to one or more power extraction means at
18 one axis of rotation, and a second power generation
19 means connected to one or more power extraction
20 means at the other axis of rotation.
21

22 15. Apparatus as claimed in claim 14, wherein the
23 first or second power generation means is
24 connectable to at least one power extraction means
25 from each axis of rotation, such that the restraint
26 of the linkage unit is maintained in the event of
27 failure of one of the power extraction or generation
28 means.
29

30 16. Apparatus as claimed in claim 14, wherein the
31 first and second power generation means is
32 connectable to one or more of the power extraction

1 means from one or both axes of rotation, such that
2 when the apparatus is operating at partial capacity,
3 the one or more power extraction means is connected
4 solely to the first or second power generation
5 means.

6
7 17. Apparatus as claimed in any preceding claim,
8 wherein constraint is applied to each power
9 extraction means of the linkage unit in order to
10 induce a cross-coupled response which may be tuned
11 to be resonant in small waves to increase power
12 capture and which may be set in large waves to limit
13 power absorption and maximise survivability.

14
15 18. Apparatus as claimed in any preceding claim,
16 wherein the apparatus includes one or more of a
17 ballasting system, mooring system, and means to
18 apply a roll bias angle to the axes of rotation.

19
20 19. Apparatus as claimed in any preceding claim,
21 wherein the linkage unit includes access means, such
22 as one or more hatches, to allow inspection, repair
23 and maintenance on or off site.

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25 20. A linkage unit for use in the apparatus of claim
26 1, comprising:

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28 linkage means for interconnection between
29 the body members permitting relative rotation
30 at either end of the unit;

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1 power extraction means adapted to resist
2 and extract power from the relative rotation of
3 the body members;

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5 the power extraction means being located
6 substantially within the linkage unit.

7
8 21. A linkage unit as claimed in claim 20, wherein
9 the linkage unit is arranged to permit relative
10 rotation between the linkage unit and a first body
11 member about a first axis of rotation at a first end
12 of the linkage unit, and to permit relative rotation
13 between the linkage unit and a second body member
14 about a second axis of rotation at a second end of
15 the linkage unit.

16
17 22. A linkage unit as claimed in claim 20 or 21,
18 wherein the power extraction means includes a
19 hydraulic ram assembly.

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21 23. Apparatus as claimed in claim 22, wherein the
22 hydraulic ram assembly comprises a plurality of
23 rams.

24
25 24. A linkage unit as claimed in claim 23, wherein
26 the power extraction means includes a hydraulic ram
27 assembly for each axis of rotation.

28
29 25. A linkage unit as claimed in claim 24, wherein
30 the power extraction means includes two hydraulic
31 ram assemblies acting about each axis of rotation.

1 26. A linkage unit as claimed in any of claims 20 to
2 25, wherein the power extraction means has at least
3 one seal to prevent ingress of water into the
4 linkage unit and/or body members.

5

6 27. A linkage unit as claimed in any of claims 20 to
7 26, wherein the linkage unit includes one or more
8 power generation or storage means connected to one
9 or more of the power extraction means.

10

11 28. A linkage unit as claimed in claim 27, wherein
12 the linkage unit includes a first power generation
13 means connected to one or more power extraction
14 means at one axis of rotation, and a second power
15 generation means connected to one or more power
16 extraction means at the other axis of rotation.

17

18 29. A linkage unit as claimed in claim 28, wherein
19 the first or second power generation means is
20 connectable to at least one power extraction means
21 from each axis of rotation, such that the restraint
22 of the linkage unit is maintained in the event of
23 failure of one of the power extraction or generation
24 means.

25

26 30. A linkage unit as claimed in claim 29, wherein
27 the first and second power generation means is
28 connectable to one or more of the power extraction
29 means from one or both axes of rotation, such that
30 when the apparatus is operating at partial capacity,
31 the one or more power extraction means is connected

1 solely to the first or second power generation
2 means.

3

4 31. A linkage unit as claimed in any of claims 20 to
5 30, wherein constraint is applied to each power
6 extraction means of the linkage unit in order to
7 induce a cross-coupled response which may be tuned
8 to be resonant in small waves to increase power
9 capture and which may be set in large waves to limit
10 power absorption and maximise survivability.

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12 32. A linkage unit as claimed in any of claims 20 to
13 31, including access means, such as one or more
14 hatches, to allow inspection, repair and maintenance
15 on site.

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17 33. A method of extracting power from waves
18 comprising the steps of:

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20 deploying an apparatus as claimed in any
21 of claims 1 to 19;

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23 orientating the structure such that a front end
24 of the structure faces into the oncoming waves;
25 and

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27 extracting the power absorbed in the or each
28 linkage unit.

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30 34. A method of manufacture of apparatus according
31 to claims 1 to 19, comprising the step of:

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1 interconnecting each pair of adjacent body
2 members of the apparatus with a linkage unit
3 according to claims 20 to 32.

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5 35. The method of claim 34, wherein the body members
6 and linkage unit(s) are connected together close to
7 or on site.

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9 36. The method of claim 34, wherein the linkage
10 unit(s) are fully assembled and tested before being
11 transported to site.